PECULIAR TRACHEAL DILATATIONS IN BITTACOMORPHA CLAVIPES FABR.[1]

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BITTACOMORPHA is a member of a very aberrant group of *Tipulidae*. In connection with two other genera it has been separated from the *Tipulidae* and considered as a distinct family. Of the genus *Bittacomorpha* only two species are known, both from North America. The species upon which these remarks are based is the commoner and more widely distributed form. It occurs from the New England states westward to the Pacific coast and has been taken as far south as Florida by Osten Sacken. In the northern states it is double brooded, and the imagines are seen during May and September, although much more commonly in the spring. The other species (*Sackenii*), which was described by Von Roeder in 1890,[2] is much more limited in its distribution and is recorded only from Nevada.

The common species (Fig. 3) is of the very slender form so characteristic of the *Tipulidae*. Its appearance is remarkable, however, on account of the peculiar black and white banding and the great inflation of the metatarsi of all the legs. The preparatory stages of a European species of the closely allied genus *Ptychoptera* have long been known, but it was only very recently that the larva and pupa of *Bittacomorpha clavipes* were discovered and figured by Hart.[3] The larva, like that of *Ptychoptera*, is aquatic, living among the submerged brushwood and sticks, which it resembles in color and external appearance. It is in this instar that we find the first peculiar modification of the tracheal system. The larva is furnished with an elon-

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[2] *Wiener Ent. Zeitung*. Heft 8, p. 230.

[3] *Bull. Illinois State Lab. Nat. Hist.* Vol. iv, p. 193.

gated breathing tube, produced by the excessive lengthening of the posterior end of the abdomen (Fig. 1). This formation is not peculiar to this species, as it occurs elsewhere, even in insects in nowise related, as in *Eristalis* among the *Syrphidae*. In the pupa we find a respiratory tube present, but in this instar its insertion is exactly reversed; it proceeds from the head. Although only one tube is functionally developed, it is one of a pair which has lengthened at the expense of its fellow (Fig. 2). Moreover, it is not always the same tube which is developed. Hart mentions that twenty-seven pupae had the right tube elongated as against three in which the left tube functioned. In one anomalous case both were developed, but unequally, their combined length being equal to that of the long one in normal pupae. This unequal length of the tubes is characteristic also of *Ptychoptera*.

Up to the present time it has not been known that the imago also possesses a remarkable modification of the tracheal system. In this stage, however, it is to be found in the legs.

In both sexes the metatarsi are very much enlarged and quite conspicuous on account of their great color contrast. The second and third tarsal joints are also somewhat enlarged, but not nearly to so great an extent.

In order to study the tracheal system of the legs they were decolorized in chlorine water and mounted whole or split into halves. Some specimens were treated also with potassium hydroxide, which successfully separated the delicate tracheae from the integument. Legs were also sectioned in paraffin to show the disposition of the internal parts.

In the basal part of the legs the tracheal tube is of the ordinary form and size. It begins to enlarge just before the middle of the femur, and before it has reached the tip is equal to seven-eighths the diameter of the femur. At this point the taenidia extend entirely around the tube, although faint in some places. The whole tibia is completely filled up by the trachea, which is striated on each side for only about one-fifteenth of its circumference. In the enlarged metatarsus the trachea is enormously distended and almost completely fills the cavity of this joint as well as that of the second and third

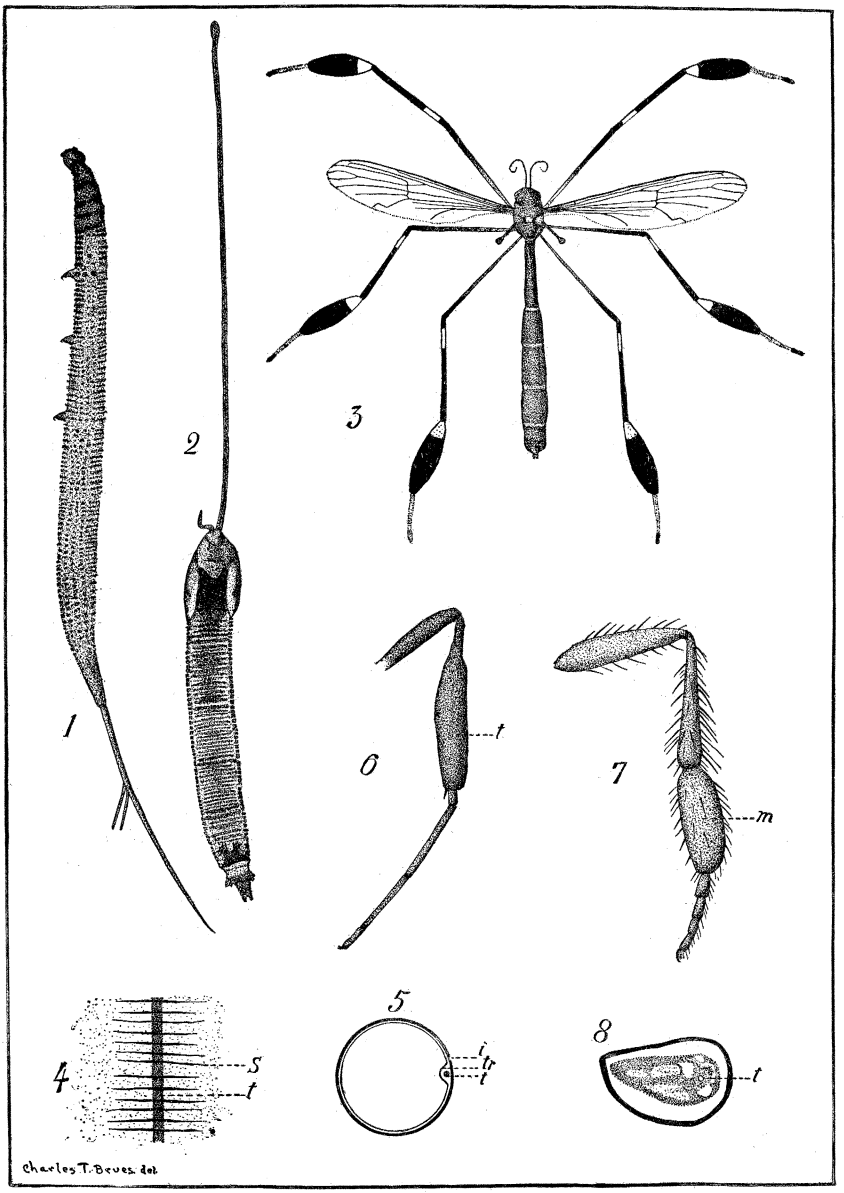

Fig. 1. Larva of *Bittacomorpha clavipes* (after Hart). — Fig. 2. Pupa of *Bittacomorpha clavipes* (after Hart). — Fig. 3. *Bittacomorpha clavipes*, in the position which it assumes when flying. — Fig. 4. Portion of tracheal wall of metatarsus of *Bittacomorpha*, showing position of tendon; *s*, taenidial striation; *t*, tendon. — Fig. 5. Diagrammatic cross-section of metatarsus of *Bittacomorpha*; *t*, tendon; *i*, chitin integument; *tr*, tracheal wall. — Fig. 6. Hind leg of *Pelecinus polyturator*, ♀; *t*, tibia. — Fig. 7. Foreleg of *Hilara trivittata*, ♂; *m*, metatarsus. — Fig. 8. Cross-section of metatarsus of *Hilara trivittata*, ♂; *t*, trachea.

joints of the tarsus. The wall of the trachea lies closely applied to the exoskeleton of the metatarsus, except for a very short distance on one side of the leg, where it is semicircularly bent inward to leave space for the claw tendon which lies in the tubular space thus formed (Fig. 5). Here as in the tibia the taenidia are visible on only about one-fifteenth of the circumference on each side.

The walls of the trachea are here not entirely destitute of taenidia, as is the case with the air vesicles which appear in the body cavities of many active insects. The striations have remained on that part of the tracheal wall which encloses the tendon (Fig. 4). At the point where the tendon passes, the taenidia are thickened and quite robust, but on each side they gradually become weak and fade out entirely. An exactly symmetrical formation of the taenidia is present on the side opposite to the tendon. It is evident that the thickenings on the tendon side may have been retained in order to strengthen the tube at this point, but there is apparently no reason for the anomalous thickening on the opposide side. In the second and third joints the taenidia lengthen until they extend over one-seventh of the circumference. The trachea seems to stop suddenly here, as I have been unable to trace it further.

There are few insects presenting similar enlargements of the leg joints, if we except those forms such as jumping *Orthoptera* and *Chrysomelidae*, where the increase in size is evidently for the accommodation of the larger muscles. Graber and Lubbock mention enlargements of the trachea in the tibiae of *Orthoptera*, ants and *Termitidae*, serving as auditory or chordotonal organs. In this case the adaptation is very extraordinary, but the dilatation of the trachea is not comparable to that of *Bittacomorpha* in extent. *Bittacomorpha* presents the only case known to me of a considerable tracheal dilatation occurring in the insect leg. In the males of many *Empididae*, and notably species of *Hilara*, e.g., *Hilara trivittata* Lw., the metatarsus of the front leg is greatly enlarged (Fig. 7), but here the cavity is occupied in great part by muscular tissue, the trachea being very slender (Fig. 8). In this species there seems to be no trachea beyond the end of the metatarsus.

In the legs of normal *Tipulidae* (*Pachyrrhina* sp.? and several other species) the trachea occupies a considerable space only in the femur and tibia, where it fills up from one-fourth to one-sixteenth of the cavity. In the tarsus the tracheal tube is very delicate or obsolete.

The female of the peculiar parasitic hymenopteron, *Pelecinus polyturator* Drury, presents an external appearance similar to that of *Bittacomorpha* in the enlarged hind tibia (Fig. 6). Here, however, the chitin of the external wall is thick and heavy, and the trachea is robust, strongly striated, but not at all dilated.

It is the rule in insects, wherever a tracheal dilation occurs, that the taenidia become obsolete, but the thinning of the tracheal wall can nearly always be regarded as a modification for the purpose of offering less resistance to osmosis. This is illustrated by the air vesicles in the bodies of insects, which are generally considered to be reservoirs for storing air to be used during extended muscular exertion. The presence of these immense vesicles in the metatarsi cannot be explained on the same principles, for it is impossible that they should serve as reservoirs for air to be used in respiration, on account of their distance from the body of the insect. It is more probable that they may bear some relation to the insect's method of locomotion. When flying, *Bittacomorpha* uses the wings scarcely at all, relying in great measure upon wind currents for transportation. The legs are exceedingly light, as the exoskeleton is thin and delicate, and encloses practically no tissue which can serve to increase their weight. As they expose a large surface, they offer great resistance to the air without adding appreciably to the insect's weight.

Drifting along thus, their extremely slender bodies and white banded appendages give them a most peculiar, intangible appearance, which is heightened by their extremely slow motion.

When examined in the cabinet, the conspicuous white and black banding of *Bittacomorpha* seems to point toward a case of warning coloration. When they are seen against their natural background, however, all these brilliant contrasts fade away into a perfectly neutral color which causes them to resem-

ble a spider's web or thistle seed drifting along. Indeed, when I first saw them it was hard to believe that they were really alive. *Bittacomorpha* seems to have developed its protective coloration along the same lines as the zebra among the vertebrates; it is rendered invisible not only by the fragmentary distribution of color, but by the neutral gray color produced by the visual blending of the black and white.

From the description of *Bittacomorpha Sackenii* by Von Roeder, it seems that this species does not possess any dilatation of the metatarsi. It would be very interesting to see if there is any abnormal development of the tracheal system in this species, but unfortunately I have been unable to procure specimens. The specimens examined were given to me by Dr. Wm. M. Wheeler, to whom I feel greatly indebted for many kind suggestions.